

**TITLE:**

5    **COUPLING ELEMENT FOR ELONGATE LAMPS AND ILLUMINATION  
SYSTEM HAVING THIS COUPLING ELEMENT**

**TECHNICAL FIELD**

10    The invention relates to a coupling element for  
elongate lamps, in particular aperture lamps. Moreover,  
the invention relates to an illumination system having  
at least two elongate lamps and at least one such  
coupling element.

15    Aperture lamps are provided with a reflector for  
visible light along their longitudinal axis on the  
inner or outer side of the lamp vessel, said reflector  
exhibiting a cutout over a defined region (=aperture)  
20    along the longitudinal axis. In the simplest case, the  
reflector is realized by a suitable thick luminescent  
material layer. As an alternative, an additional  
reflection layer may also be arranged underneath the  
luminescent material layer. In this case, the  
25    luminescent material layer, which is thinner here, may  
also extend over the entire aperture. In any event, the  
light generated within the lamp essentially passes only  
through the aperture toward the outside. As a result, a  
higher luminance is obtained within the aperture than  
30    without a reflector. Moreover, the light is essentially  
directed, i.e. emitted within an angular range which is  
advantageous for a highest possible illumination  
intensity.

35    Lamps of this type are used for example in exposure  
units for copiers, scanners, fax machines and similar  
devices appertaining to office automation, so-called  
OA devices (OA = Office Automation). However, other  
areas of use in which a preferred emission angle range

is desirable are also conceivable, for example in automotive technology, e.g. as an indicator or brake light, and for interior illumination.

5 Many applications require lamps of different lengths, e.g. for scanner areas of different sizes. By way of example, there are devices which are suitable for documents up to A3 size, but there are also others which are suitable up to A2 or even up to A0. These  
10 require in each case different lamps of corresponding length.

#### **BACKGROUND ART**

15 US 6 097 155 discloses a tubular aperture fluorescent lamp having a base with two connecting pins at one end. The lamp additionally has, parallel to the tube longitudinal axis, two diametrically arranged strip-type electrodes, one on the outer side and the other on  
20 the inner side of the discharge vessel wall. The two electrodes are connected to the two connecting pins in the interior of the base. For their part, the connecting pins are connected to the two poles of a pulse voltage source via electrical lines. The lamp is  
25 distinguished by a relatively high useful radiation efficiency.

#### **DISCLOSURE OF THE INVENTION**

30 The object of the present invention is to provide an illumination system whose luminous length can be adapted relatively simply to different requirements.

This object is achieved by means of a coupling element  
35 for the combining of at least two elongate lamps with in each case two ends, the coupling element having a continuous receptacle area which is provided for

receiving an end of each lamp, which receptacle area comprises a reflector.

5 The advantage of the invention is that, with two or more lamps having a specific length in conjunction with one or a plurality of coupling elements according to the invention, illumination systems having different luminous lengths can be realized in a modular manner.

10 The basic concept of the invention firstly consists in connecting instead of a single elongate lamp having the length  $n \cdot L$  ( $n=2, 3, 4, \dots$ )  $n$  elongate lamps, each having the length  $L$ , at their ends to a respective special coupling element to form an illumination system. Thus,  
15 in order to connect  $n$  lamps in this way,  $n-1$  coupling elements are necessary. The invention is to be understood in a generalized manner to the effect that the individual lamps need not necessarily be connected along a straight line. Rather, angular structures are  
20 also intended to be included. In order to reduce the luminance decrease in the region between the lamp ends, the receptacle area of each coupling element comprises a reflector.

25 The light which emerges through one lamp end firstly impinges on the opposite lamp end and there is either coupled into this lamp or reflected from the surface thereof. The light coupled into the opposite lamp advantageously contributes to minimizing the otherwise  
30 unavoidable light decrease at the end of this lamp. The light reflected at the second lamp either passes directly toward the outside as usable light or it is reflected back onto the first lamp or it impinges on the receptacle area of the coupling element, in  
35 particular on the reflector. At the core, axially emerging light is therefore deflected in a lateral direction and can thus be utilized for the illumination

purposes of elongate lamps as mentioned in the introduction.

Although the invention manifests its advantageous  
5 effect with all elongate lamps which emit a significant proportion of their luminous flux through the end side of one or both lamp ends, elongate lamps based on dielectrically impeded discharges with strip-type electrodes have proved to be particularly advantageous.  
10 The strip-type electrodes are arranged either on the outer side or inner side of the wall of the elongate discharge vessel. This form of the electrodes in contrast to conventional electrodes fitted at the respective end sides of the cylindrical discharge  
15 vessel also enables the length of the non-luminous ends to be kept minimal. At the same time, a considerable luminous flux is coupled out from the end faces of the ends in the axial direction since, by virtue of the luminescent material coating in the case of fluorescent  
20 lamps or by virtue of the reflector coating in the case of aperture lamps, the tubular discharge vessel acts like an optical waveguide which guides the light along the tube axis.

25 The reflector of the coupling element<sup>1</sup> is realized either by a diffusely reflective area or by a reflective area, e.g. by a reflective foil arranged on the receptacle area. In this case, however, the reflector need not necessarily be realized by a  
30 separate means, but rather may also be formed by the coupling element itself, for example in that the coupling element comprises a suitable reflective material or has a suitable color, for example white or in that the receptacle area of the coupling element is  
35 correspondingly processed, e.g. polished. What is crucial is that there are no absorbent areas in the region between the end sides of the lamp ends, since this would lead to considerable light losses owing to

the multiple reflection. In this sense, therefore, the receptacle area is formed in continuous fashion. Nevertheless, the receptacle area or the coupling element need not necessarily be in one part, but rather  
5 may also be composed of two or more parts. With regard to the effect of the coupling element according to the invention, reference is supplementarily made to the exemplary embodiments.

10 Moreover, the ends of two lamps are preferably arranged within the coupling element such that the end sides of the two lamps are arranged as near as possible to one another without touching one another, typically with a distance of approximately 1 mm. On the one hand, this  
15 prevents stresses from arising if the lamps expand thermally during operation. On the other hand, the spatial extent of the luminance decrease caused by the gap between the two end sides is kept as small as possible. In order to simplify the arrangement of the  
20 lamp ends with minimal mutual distance between the end sides, it is advantageous to provide the coupling element with a suitable stop. Said stop may be realized e.g. in the form of a lug-like elevation in the receptacle area, the width of the elevation in the  
25 longitudinal direction defining the minimal mutual distance between the end sides. In this respect, the term "continuous receptacle area" is intended to encompass such a stop in the receptacle area which does not effect complete separation between the two lamp  
30 ends.

In a preferred embodiment, the coupling element is provided for receiving lamps with a tubular lamp vessel, the receptacle area being adapted to the  
35 tubular curvature of the outer side of the lamp vessel to be received. For this purpose, the receptacle area may be realized for example by the inner area of a half-shell. Since a half-shell inevitably leaves a

light exit opening free, the half-shell itself may  
comprise a light-opaque material. This does not hold  
true if the coupling element is alternatively formed as  
a hollow cylinder. This is because, in order actually  
5 to enable light emission, the hollow cylinder must be  
produced from a light-transmissive material, for  
example Plexiglas. A part of the inner area is  
developed as a reflector area, the light exit area  
remaining free. As an alternative, the coupling element  
10 may also be produced from a parallelepiped, the  
receptacle area being realized by a suitable hole in  
said parallelepiped. If the hole is not completely  
enclosed within the parallelepiped, but rather forms a  
perforation which enables a light exit, the  
15 parallelepiped may likewise comprise a light opaque  
material. In any event, a part of the inner area is  
developed as a reflector area in this case as well. The  
parallelepiped form has the advantage that the coupling  
element formed in this way simultaneously serves as a  
20 lamp base and, by way of example, can be mounted on a  
lamp carrier, if appropriate with additional mounting  
means.

If more than two lamps, for example three lamps, are  
25 connected to one another via the coupling elements  
according to the invention to form an illumination  
system, it is necessary for at least one of the two  
coupling elements to be provided with electrical  
contacts in order also to be able to connect the  
30 "central" lamp to an electrical power supply. At least  
one of the two "outer" lamps is usually connected to an  
electrical power supply via the base terminal of its  
free end. The situation for the "central" lamp proves  
to be particularly simple if each lamp is provided with  
35 strip-type electrodes arranged on the outer side of the  
lamp vessel. It then suffices for a coupling element to  
be provided with contact areas, e.g. with elongate  
spring contacts arranged along the longitudinal axis of

the receptacle area, which connect the electrodes of an "outer" lamp to the corresponding electrodes of the "central" lamp. It is thus also possible, in principle, to supply all the lamps with a single electrical power supply, namely if all the coupling elements are provided with the abovementioned contacts. However, it will generally be more expedient to supply at least the two outer ends in each case with an electrical power supply in order to implement the modular character of this concept on the part of the electrical power supply as well. In this sense, it may also be expedient to provide a coupling element with additional terminals for an electrical power supply.

15 In a further variant, the coupling element is in two parts. The two parts may be fixedly connected to one another e.g. by means of a clip closure. In this way, each lamp may be produced as an individual part and then be directly combined on site during mounting without additional parts.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be explained in more detail below with reference to exemplary embodiments. In the figures:

Figure 1a shows a partial longitudinal section of an illumination system according to the invention with two aperture lamps connected by means of a coupling element in the form of a half-shell,

Figure 1b shows a cross section of the illumination system from figure 1a along the line Ia-Ib,

Figure 2a shows a partial longitudinal section of a further variant, in which two aperture lamps

are connected by means of a coupling element  
in the form of a hollow cylinder,

5       Figure 2b   shows a cross section of the illumination  
                  system from figure 2a,

10       Figure 3a   shows a partial longitudinal section of a  
                  variant in which two aperture lamps are  
                  connected by means of a parallelepipedal  
                  coupling element,

      Figure 3b   shows a cross section of the illumination  
                  system from figure 3a,

15       Figure 4a   shows a partial longitudinal section of a  
                  further variant with a two-part coupling  
                  element in the connected state,

20       Figure 4b   shows a cross section of the illumination  
                  system from figure 4a,

      Figure 4c   shows a partial longitudinal section of the  
                  two-part variant from figure 4a, but in the  
                  separated state,

25       Figure 5    shows a partial longitudinal section of a  
                  further variant, the coupling element having  
                  electrical contacts,

30       Figure 6    shows a graphical illustration of  
                  illumination intensities measured along the  
                  illumination system of figures 1a, 1b.

#### **BEST MODE FOR CARRYING OUT THE INVENTION**

35       Figures 1a, 1b diagrammatically show a longitudinal  
          section and, respectively, a cross section along the  
          line Ia-Ib of an elongate illumination system 1



according to the invention with two rod-type aperture  
florescent lamps 3 (only partially illustrated) coupled  
by means of a coupling element 2.

5 Each lamp 3 has two linear electrodes 4 arranged on the  
inner side of the wall of the lamp vessel diametrically  
and parallel to the longitudinal axis of the rod-type  
lamp 3 (only one of the two electrodes can be seen in  
the longitudinal section; the electrodes cannot be  
10 discerned in the cross section). The electrodes 4 are  
covered with a glass solder layer (not illustrated),  
which acts as a dielectric barrier with regard to the  
interior of the lamp vessel, i.e. with regard to the  
discharge during lamp operation. Thus, a discharge  
15 which is dielectrically impeded on both sides is  
involved in this case. The inner side of the wall of  
the lamp vessel has a luminescent material layer 5, an  
elongate aperture oriented parallel to the lamp  
longitudinal axis being cut out. A xenon-neon mixture  
20 with a xenon partial pressure of approximately 15 kPa  
is situated in the interior of the lamp vessel. For the  
rest, the lamp 3 essentially corresponds to the lamp  
disclosed in US-A 2002/0163306. Therefore, for further  
details, which, however, at most play a secondary role  
25 here, reference is made to the disclose content of this  
document, in particular to its figures 3 and 5 with the  
associated description of the figures.

The coupling element 2 is formed from a non-transparent  
30 plastic material as a half-shell in which a respective  
end of the two lamps 3 is arranged. In this case, the  
half-shell 2 terminates with the extent of the  
luminescent material layer 5, i.e. it ends at the edge  
of the aperture. The mutual distance a between the lamp  
35 ends in the coupling element 2 is approximately 1 mm.  
The concave inner side of the coupling element 2 is  
reflection-coated with an aluminum foil 6.

Figures 2a, 2b diagrammatically show a variant of the above exemplary embodiment. In this case, features identical to those in figures 1a, 1b are provided with identical reference symbols. Here, the coupling element  
5 is formed from a transparent plastic material as a hollow cylinder 7. The extent of the reflective layer 6 on the inner side of the hollow cylinder 7 is here likewise adapted to the extent of the luminescent material layer 5, i.e. the aperture here, too, is of  
10 course not reflection-coated.

In the variant illustrated diagrammatically in figures 3a, 3b, the coupling element is developed as a parallelepipedal lamp base 8 having a half-shell-type  
15 recess for receiving a respective end of the two lamps 3. The planar basal area 9 of this embodiment is suitable for mounting on a lamp carrier. Moreover, a lug-type stop 10 is additionally provided centrally on the inner side of the coupling element 8, and  
20 facilitates the setting of the mutual distance a between the ends of the two lamps 3.

The variant illustrated diagrammatically in figures 4a to 4c differs from the embodiment illustrated in  
25 figures 3a, 3b merely by the fact that the coupling element 11 is embodied in two parts. The two parts can be fixedly connected to one another by means of a latching lug 12 and an associated opening 13.

30 Figure 5 diagrammatically shows a variant in which the linear electrodes 14 are arranged on the outer side of the vessel of the lamps 15. Thus, the vessel wall here serves as a dielectric for the dielectrically impeded discharge. The coupling element 14 has two elongate  
35 contact springs 17, which electrically conductively connect the two outer electrodes 14 of one lamp 15 to the two outer electrodes 14 of the other lamp 15.

Figure 6 shows the relative profile - measured at a distance of 8 mm above the aperture - of the illumination intensity (y-axis) for the exemplary embodiment in figures 1a, 1b, where L1 and L2 symbolize the two lamps. The measurement curves 18, 19 show the results with and without a reflective foil within the coupling element. Without a reflective foil, the illumination intensity decreases by approximately 20% in the transition region between the two lamp ends (the measurement location is illustrated on the x axis). With a reflective foil, the decrease in the relative illumination intensity is reduced by approximately 25%. Moreover, it can be seen that the minimum is wider, i.e. the narrow dark zone is compensated for according to the invention by a wider brighter zone.

The above examples in each case show systems with two lamps which are connected to one another via one coupling element. It goes without saying, however, that the invention also encompasses systems with three or more lamps, two or correspondingly more coupling elements then being required, as has already been explained in the introduction.